SUSTAIN ABILITY

ACTUARIES AND THE FUTURE

Resilience Reserve Taskforce Report

Anthony Asher (Convenor), Colin Grenfell, Anton Kapel, Martin Paino, Ken Ragell, Michael Sherris & James Wang

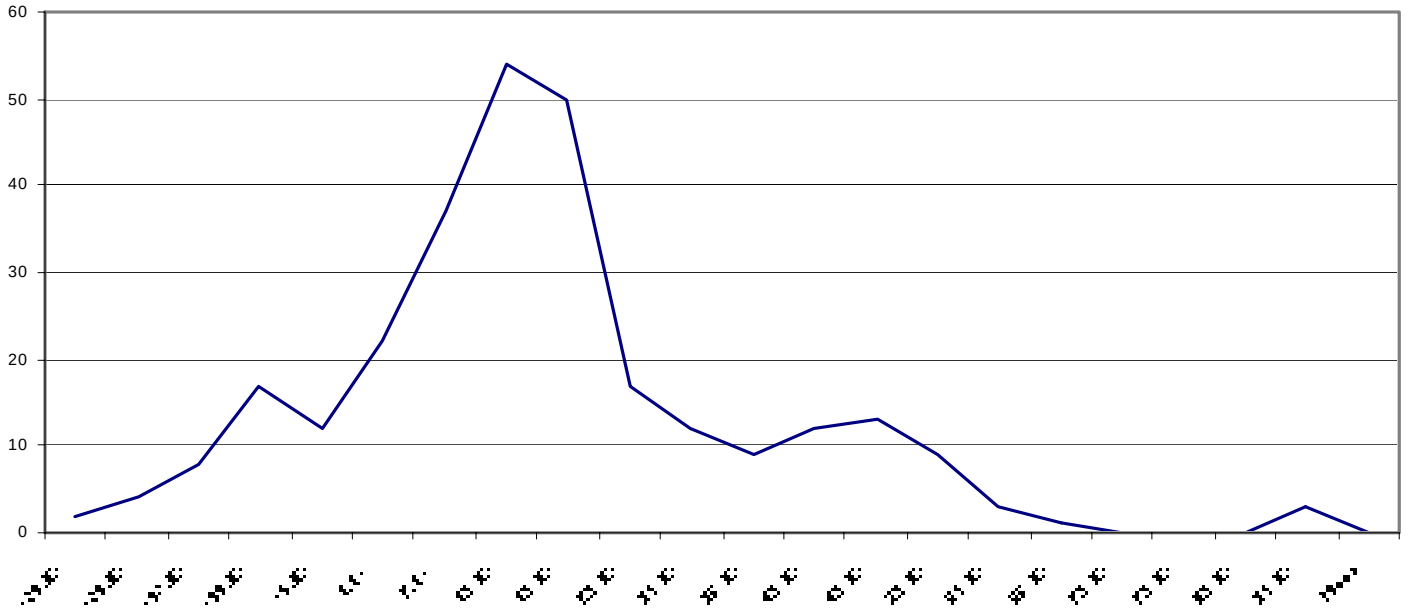
Institute of Actuaries of Australia

Introduction

- Refresh - ten years on
- Modeling
  - Tail probabilities
  - Correlation
  - Other factors
- Diversification factor
- Mean reversion
- Credit risks

Tail probabilities

Australian annual equity returns (rolling average)



Correlations

- **Required for:**
  - **Classification of assets**
  - **Diversification**
- **Are non-linear and variable**
  - **Different in the tails**
  - **Change over time**

Figure 2: Quantile correlations for equity and property

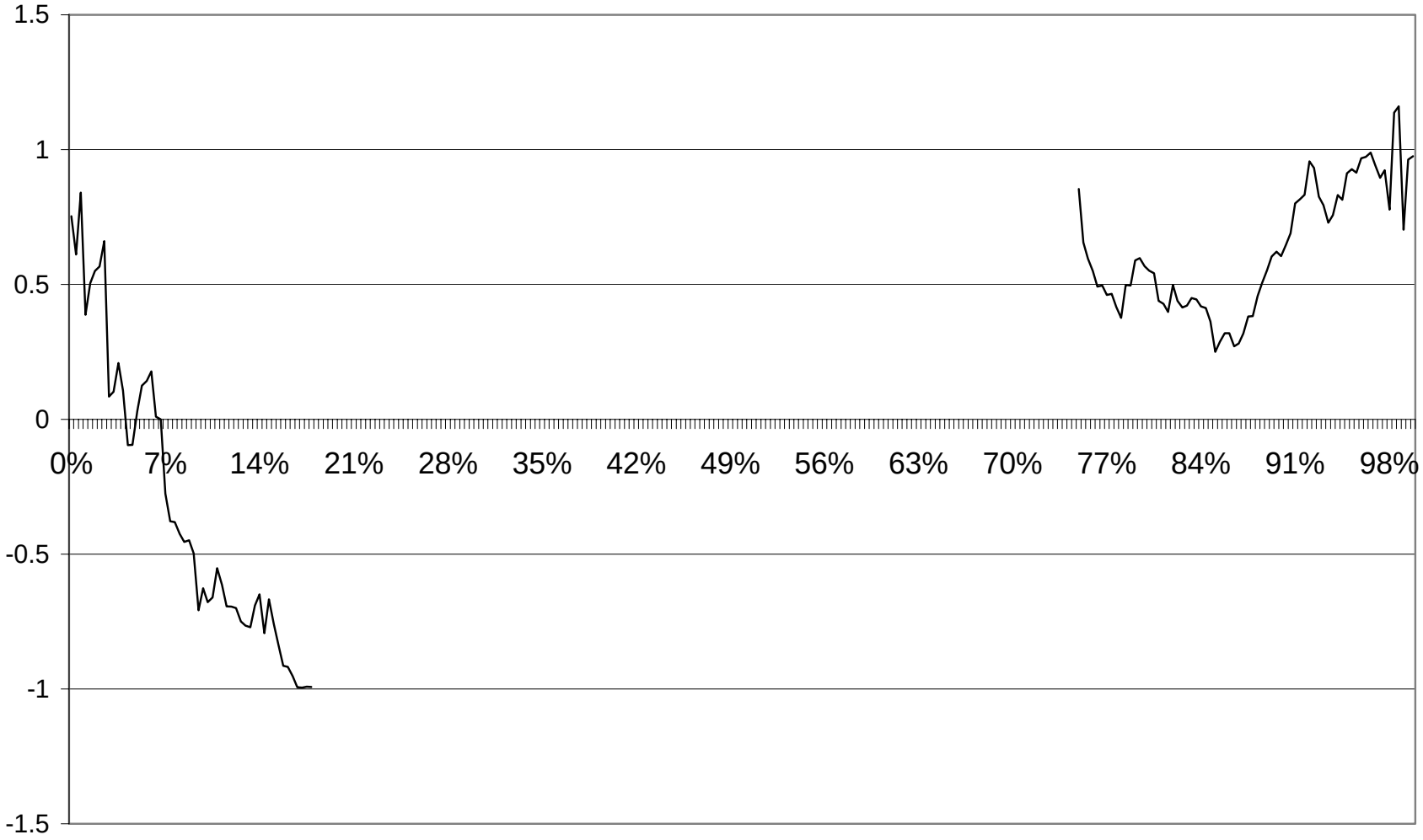


Figure 4 : Accumulation indices in A$

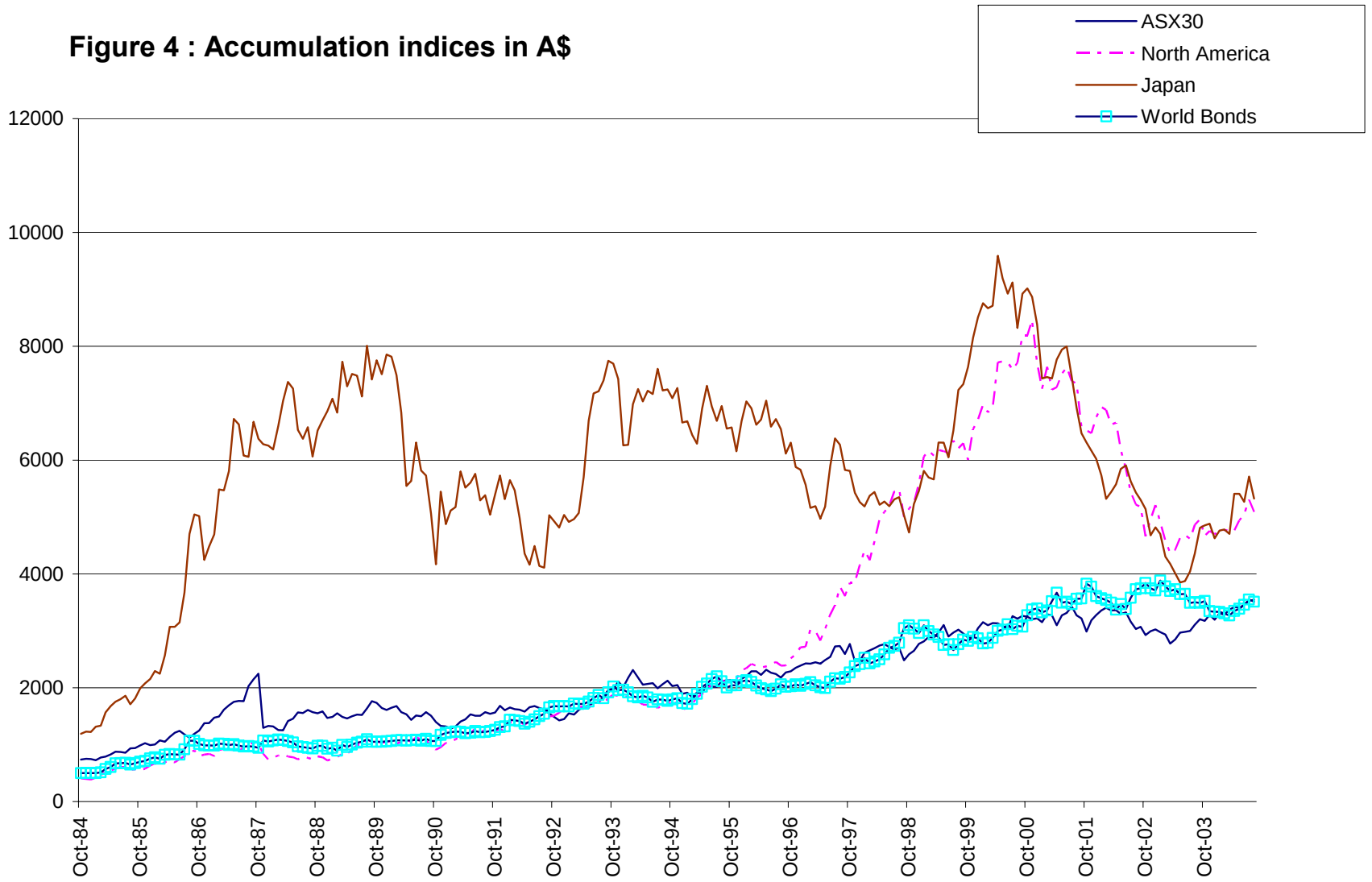
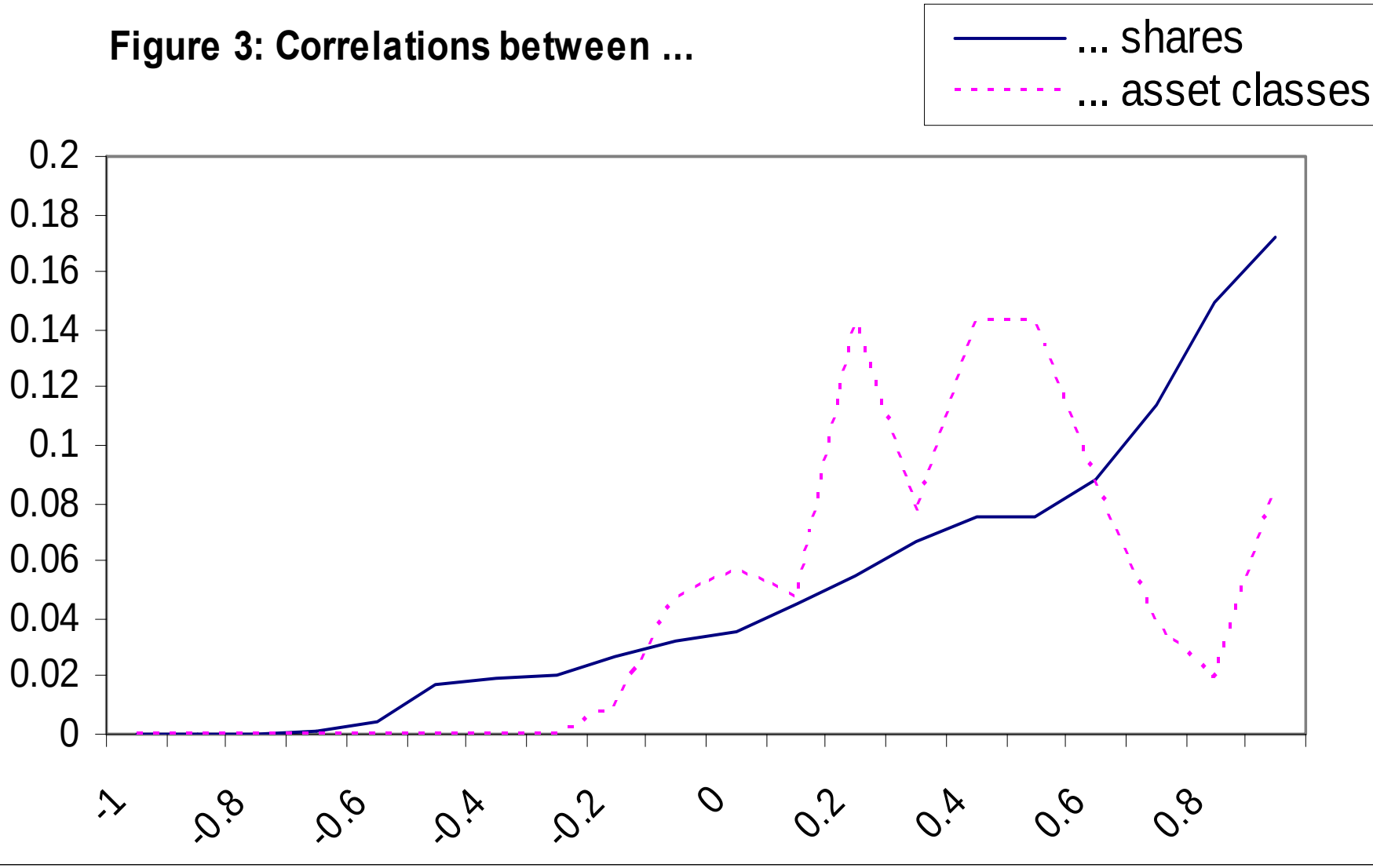


Figure 3: Correlations between ...



Diversification factor

- Inconsistencies in the current factor
- A theoretical approach
- The implications

Table 5: Apparent inconsistencies in the existing diversification factor

		Term of fixed interest: 7		Term of fixed interest: 1	
	Yield	Proportion invested	Diversification factor	Proportion invested	Diversification factor
Equities	0.04	99%	1.00	99%	1.00
Fixed interest	0.05	1%		1%	
Equities	0.04	50%	0.77	50%	0.95
Fixed interest	0.05	50%		50%	
Equities	0.04	1%	0.98	1%	0.86
Fixed interest	0.05	99%		99%	

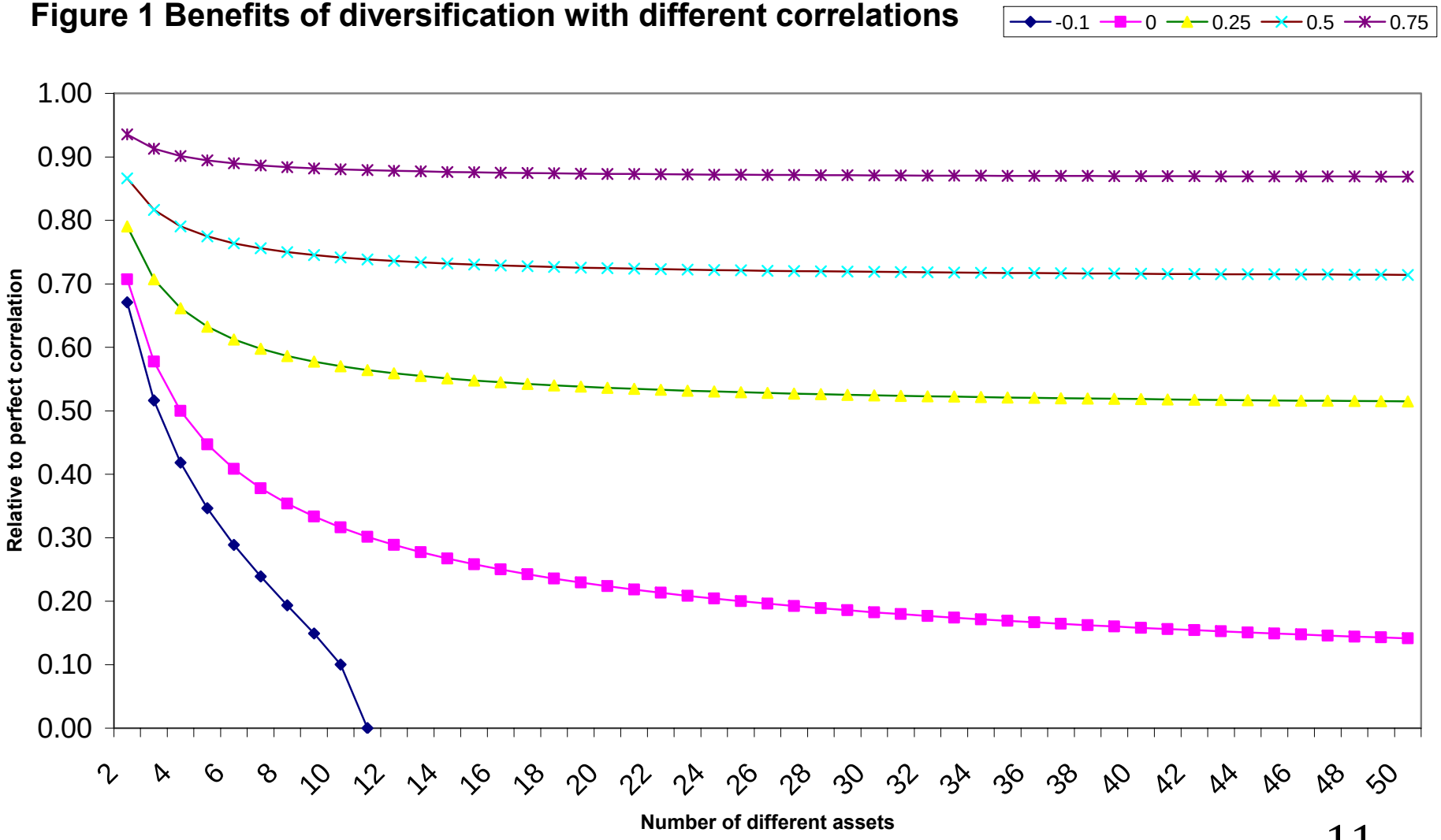
Diversification factor

$$\sigma^2(P) = \sum_{i=1}^{n} k_i^2 \sigma_i^2 + 2 \sum_{j}^{n} \sum_{i}^{j-1} k_i k_j \operatorname{cov}(X_i X_j)$$

$$\sigma^2(S) = k_e^2 \sigma_e^2 + k_{i(A)}^2 \sigma_{i(A)}^2 + (-1)^2 \sigma_L^2$$

$$+ 2[k_e k_{i(A)} \rho_{ei(A)} \sigma_e \sigma_{i(A)} + k_e (-1) \rho_{eL} \sigma_e \sigma_L + k_{i(A)} (-1) \rho_{Li(A)} \sigma_L \sigma_{i(A)}]$$

Figure 1 Benefits of diversification with different correlations



Asset classification

- International equities
- Property
- Different sectors
- Other assets

Table 6: Effects of proposal for new approach to diversification							
		Long term fixed interest assets			Short term fixed interest assets		
	Yield	Proportion invested	Diversific-ation factor	Resilience reserve	Proportion invested	Diversific-ation factor	Resilience reserve
Scenario 1							
Equities	0.04	99%	1.00		99%	1.00	
Fixed interest	0.05	1%			1%		
CURRENT	Long fixed interest liabilities			47%			47%
	Short fixed interest liabilities			33%			33%
PROPOSED	Long fixed interest liabilities			30.9%			30.9%
	Short fixed interest liabilities			30.6%			30.6%

Table 6: Effects of proposal for new approach to diversification

		Long term fixed interest assets			Short term fixed interest assets		
	Yield	Proportion invested	Diversific-ation factor	Resilience reserve	Proportion invested	Diversific-ation factor	Resilience reserve
Scenario 2							
Equities	0.04	30%	0.71		30%	0.89	
Fixed interest	0.05	70%			70%		
CURRENT	Long fixed interest liabilities			11.5%			18.7%
	Short fixed interest liabilities			11.0%			7.6%
PROPOSED	Long fixed interest liabilities			9.4%			13.0%
	Short fixed interest liabilities			12.6%			9.3%

Table 6: Effects of proposal for new approach to diversification

		Long term fixed interest assets			Short term fixed interest assets		
	Yield	Proportion invested	Diversific-ation factor	Resilience reserve	Proportion invested	Diversific-ation factor	Resilience reserve
Scenario 3							
Equities	0.04	1%	0.98		1%	0.86	
Fixed interest	0.05	99%			99%		
CURRENT	Long fixed interest liabilities			0.6%			10.8%
	Short fixed interest liabilities			11.2%			0.5%
PROPOSED	Long fixed interest liabilities			0.3%			10.5%
	Short fixed interest liabilities			10.4%			0.3%

Other factors

- **Mean reversion:**
  - Tendency to return to long term mean
- **Serial correlation:**
  - Tendency to overshoot and correct
- **Fundamental variables:**
  - Earnings yields vs interest rates
  - Tobin's q (market:book value)
  - Profits: GNP

Mean reversion

$$DY_{t+1} - DY_t = \kappa(DY_{average} - DY_t) + \varepsilon_t$$

$$DY_{t+1} = \kappa DY_{average} - (1-\kappa)DY_t + \varepsilon_t$$

Currently assume Κ = 0.

If not, is ε_t smaller or more symmetrical?

Mean reversion statistics

	κ	10 year mean	R^2
Dividend yields	50%	4.0%	25%
Property yields	80%	7.5%	40%
Real interest rates	25%	3.0%	20%
Anticipated inflation	55%	2.5%	40%

Mean reversion suggestions

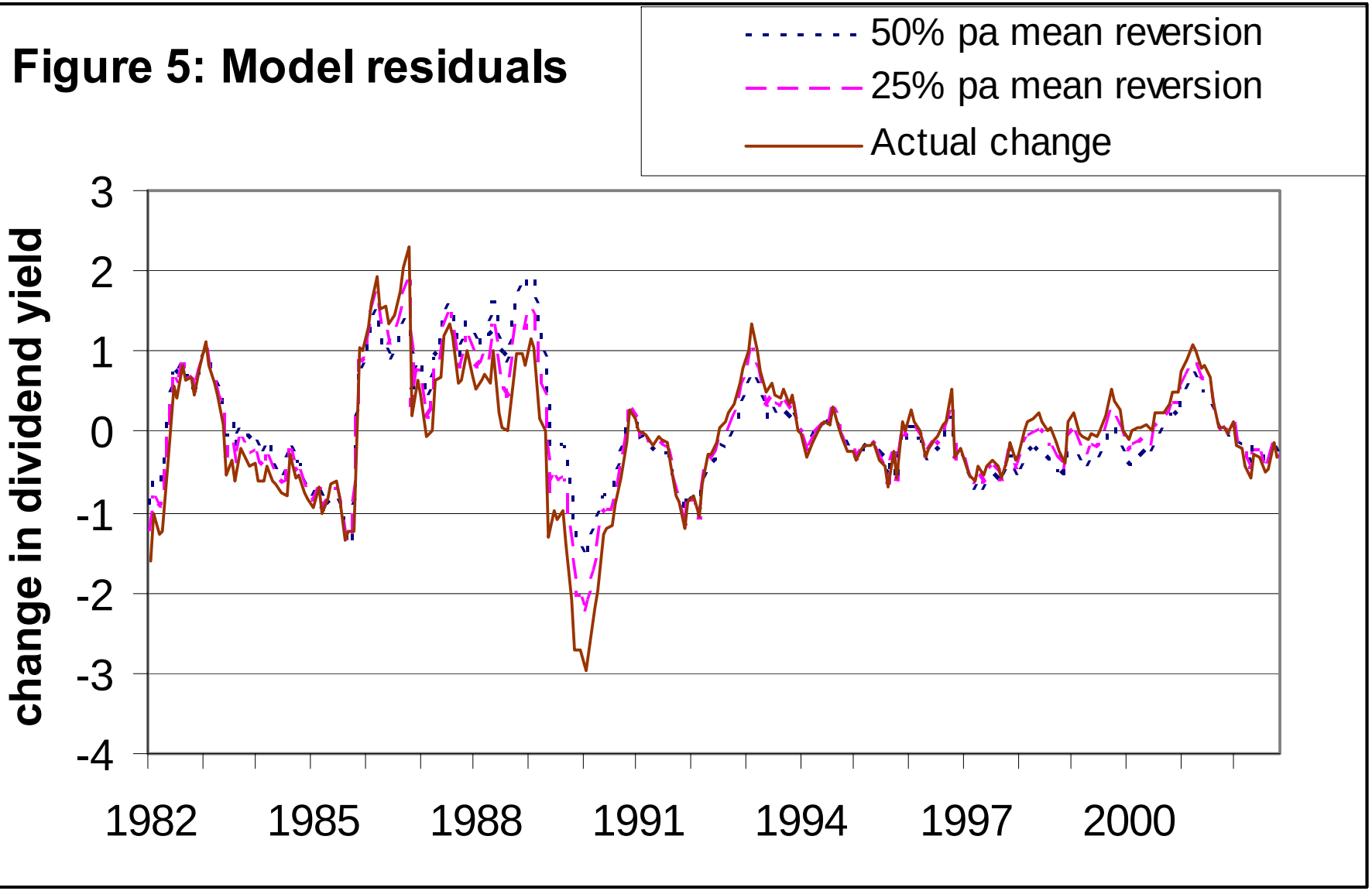
Summary Table	κ	10 year mean	R^2	*Suggested mean*
Dividend yields	50%	4.0%	25%	*4.0%*
Property yields	80%	7.5%	40%	*7.6%*
Real interest rates	25%	3.0%	20%	*3.4%*
Anticipated inflation	55%	2.5%	40%	*3.0%*
Suggested rated of mean reversion for all parameters				*25%*

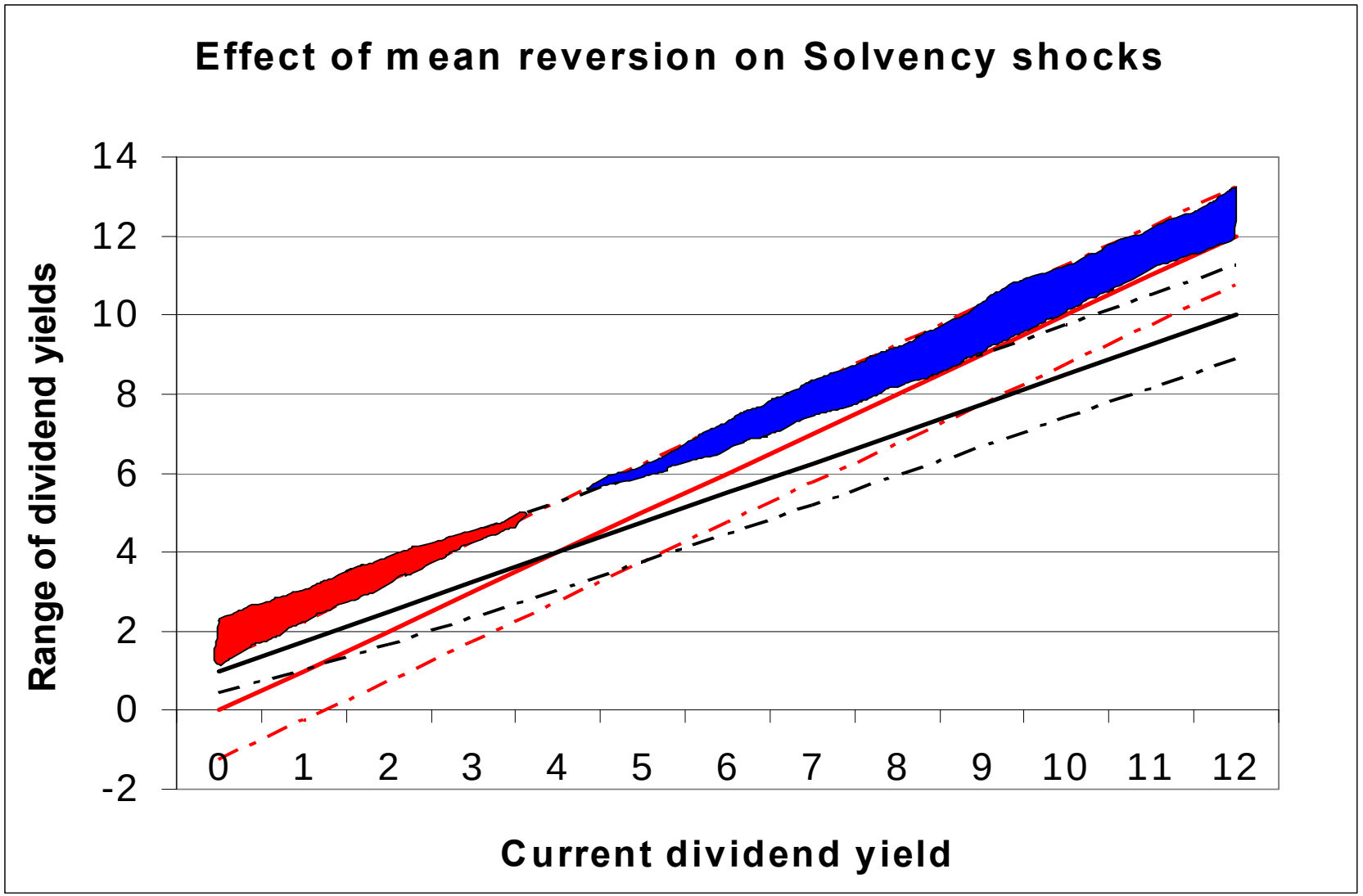
Table 3 Improved fit?

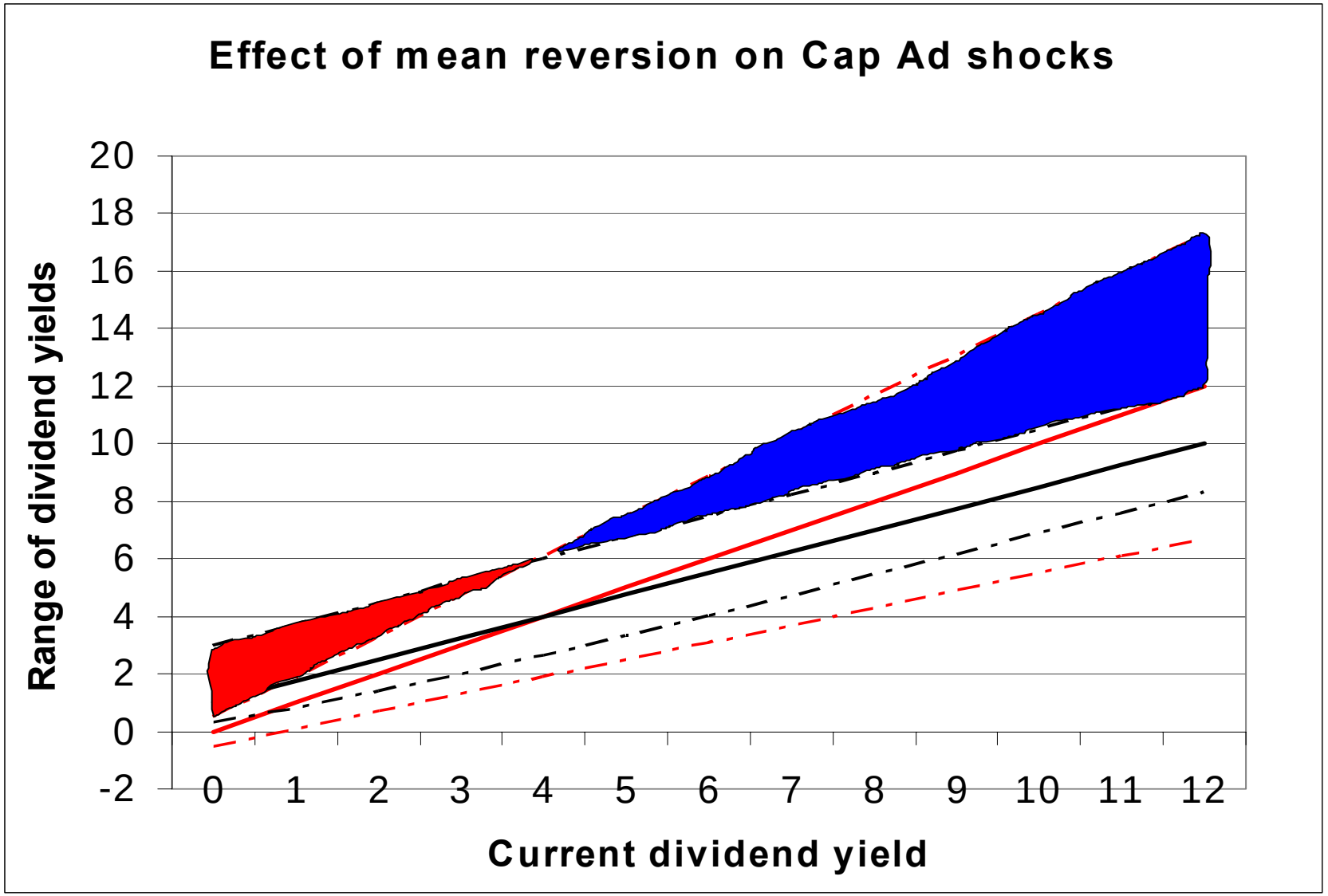
	Against start of the year (%)		Against mean reverted value (%)	
	When greater than average	When less than average	When greater than average	When less than average
Panel A: Change in dividend yield over the year (Australian equities)				
Max	**1.35**	**2.29**	**1.35**	**1.71**
Min	**-2.98**	**-1.25**	**-2.48**	**-1.52**
Mean	**-0.32**	**0.19**	**-0.32**	**0.13**
Standard deviation	**0.90**	**0.64**	**0.85**	**0.59**
Panel B: Change in real interest rates over the year				
Max	**2.18**	**2.26**	**2.21**	**2.26**
Min	**-1.40**	**-.58**	**-1.06**	**-0.58**
Mean	**-0.19**	**0.28**	**0.12**	**0.24**
Standard deviation	**0.68**	**0.62**	**0.65**	**0.62**

Table 3 Improved fit?				
	Against start of the year (%)		Against mean reverted value (%)	
	When greater than average	When less than average	When greater than average	When less than average
Panel C: Change in anticipated inflation over the year (last 20 years)				
Max	**2.15**	**2.06**	**3.24**	**1.92**
Min	**-3.63**	**-1.09**	**-2.34**	**-1.06**
Mean	**-0.58**	**0.12**	**0.21**	**-0.01**
Standard deviation	**1.15**	**0.68**	**1.17**	**0.62**
Panel D: Change in anticipated inflation over the year (last 10 years)				
Max	**0.90**	**2.06**	**1.03**	**1.77**
Min	**-1.54**	**-1.09**	**-1.31**	**-1.06**
Mean	**-0.70**	**0.10**	**-0.45**	**-0.03**
Standard deviation	**0.55**	**0.65**	**0.55**	**0.58**

Figure 5: Model residuals




Effect of mean reversion on Solvency shocks
Range of dividend yields
14
12
10
8
6
4
2
0
-2
0
1
2
3
4
5
6
7
8
9
10
11
12
Current dividend yield


Effect of mean reversion on Cap Ad shocks
Range of dividend yields
20
18
16
14
12
10
8
6
4
2
0
-2
0
1
2
3
4
5
6
7
8
9
10
11
12
Current dividend yield

Credit risks

- **Elements of credit risk**
  - **Defaults**
  - **Transition from one category to another**
  - **Change in market credit spreads**
- **Granularity?**

Table 4: Credit factors				
Rating (S&P)	Default Factor (Solvency)	Default Factor (Capital Adequacy)	Yield Movement (Solvency)	Yield Movement (Capital Adequacy)
AA *	0.25%	0.3%	0.3%	0.5%
A	0.5%	0.7%	0.4%	0.6%
BBB	1.5%	2.2%	0.5%	0.8%
BB	3.5%	5.0%	0.6%	0.9%
B	7%	10%	0.7%	1.0%
Below	10%	15%	0.8%	1.2%

*** We suggest that only OECD central and state governments rated AAA should not be loaded for credit; all other borrowers treated as AA.**

Other issues

- Application to individual portfolios
- Reinvestment
- Yield curve slope and shape
- Gearing, derivatives and hybrids
- Inadmissible assets

Suggested form

$$RR = L''*A/\{A''-\sqrt{[E^2+F^2+K^2+2(.2(EF-EK)-FK)]}\} - L$$

L’	determined after mean reversion
A’’	… after mean reversion and credit shock
E	dollar value of equity shock
F	dollar value of fixed interest shock
K	dollar value of liability shock

Yield shock increases

	Solvency	Capital Adequacy
Real interest rates:	0.8	1.2
Anticipated inflation:	0.2	0.5
	+20% F	+30% F
Dividend yields:	1.25	2.0
Currency:	14%	20%

Conclusion

Questions?

Comments?

- Mean reversion
- Classification of assets (esp. property)
- New approach to diversification
- Credit risks
- Parameters